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Why do Firms Incorporate and what Difference does it Make?

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Abstract (4/14/19)

Economic history suggests that technological innovations with long productivity delays contributed to the emergence of corporations. We develop a theory, with supporting evidence, explaining why in a competitive economy proprietors chose to incorporate, because of the difference in the contracts each can make. Corporations, because their equity is transferable, are not restricted to pay factors their marginal product, and therefore can use advanced technologies with long lags more efficiently, and distribute the resulting output as income optimally. Hence, corporations cause economic growth, eliminate competitive market failures, reduce income inequality, and can be viewed as "social organizations" similar to non-coercive "mini-Governments".

JEL: O3-4, D2, L2

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I. Introduction

The prosperity of Western free market capitalist economies has been attributed to the accumulation of financial capital and adoption of technological innovations. Efforts to replicate Western success in less developed countries through capital infusion and technology transfers were spectacularly successful for the "Asian Tigers" but much less so elsewhere. Acemoglu and Robinson (2005) argue that economic institutions are central to such economic outcomes because they influence whether or not resources are allocated to their most efficient uses.

We believe one of the most fundamental, if neglected, differences in economic institutions between countries is the type of firms that produces output; unincorporated versus incorporated. Corporations dominate advanced western economies, yet economic models typically do not distinguish between the kind of contracts a corporation and a self-employed proprietor (SEP) can rationally make. The conventional view, that there is no difference between these two types of firms, is illustrated by the statement that a firm is a "nexus of contractual arrangements" between individuals, Jensen and Meckling (1976), and the characterization of a firm as "a ... particular cluster of otherwise ordinary contractual relationships" that exist to reduce contracting, transactions, information, or risk costs, Gibbon's (2005).[1] The same has been said about production in economic modeling. Indeed, Magill and Quinzii state that "the production plans for a corporation are the same as for" an unincorporated firm (2002, p. 386).

A proprietorship, i.e. an unincorporated firm,[2] is legally identical to its owner(s)/employee(s). It ceases to exist upon the individual's death, and any contract made by an individual becomes void upon their death.[3] Thus, a finite lived proprietor can only use a technology with productivity delays longer than their lifespan if they can make and sell a forward contract for the output produced using such advanced technology to the next generation. It is a pillar of (neoclassical) economics that a firm in a competitive market must pay the factors of production it uses their (current) marginal products. This is correct when the firm is a proprietor. In contrast, a corporation is a separate legal entity from its equity owners or employees and its equity

[1] These views reflects Coase (1937) and Knight's (1921) hypotheses of why firms exist, but they did not distinguish between corporations and SEPs

[2] We will use the term proprietor to apply to all unincorporated firm. In fact in the U.S. economy the majority of all firms are sole proprietorships, 73.1%, 8.2% are partnerships, and 18.7% are corporations (of various kinds), Pomerleau (2015).

[3] http://www.businessdictionary.com/definition/contracting-party.html

ownership can be transferred from one generation to another,[4] making a corporation potentially deathless. The lifetime contracts that a corporation can make with its current and all future stakeholders also allow it to allocate its inputs in the most productive intertemporal pattern, e.g. one in which productivity is increased in the distant future, and to distribute its revenue as income to its employees and equity owners in whatever intertemporal pattern that is optimal for them, independent of the (current) marginal product of the factors of production which they own and the corporation uses. The resulting increase in productivity, income, and welfare provides an incentive for a proprietorship to incorporate as soon as a more productive technology with output delay longer than an agent's lifetime becomes available.[5]

We demonstrate that when there is no, or a short, delay between the investment into the creation, adoption, and use of new technology and the subsequent increase in productivity that the conventional view, that there is no difference between the contracts a corporation and a proprietor can make and thus the productivity and income distribution that either type of firm can choose, is correct. This is because, in this case, there is no difference between paying factors of production their current and (the present value of) their lifetime marginal products and therefore no advantage to incorporation.

However, when an advanced technology results in an increase in productivity that is delayed longer than the (working) lifespan of an individual, e.g. transportation by railroads across country, or by ships around the Cape of Good Hope, and inputs include the initial resources necessary to establish the complex structures (technologies) involved, we demonstrate that the conventional view is incorrect. A corporation, because it is potentially deathless, can make complex contracts or plans that are irrational for a proprietor. This paper presents a theoretical model, and supporting empirical evidence, that explains how the emergence of the corporation can be explained by technological innovations with long productivity delays, independent of contracting, transactions, and information costs or the acquisition of capital.

We use the term productivity "delay" to distinguish this concept from that of a "lag" between the inputs of labor and capital into the production function and the resulting output in production theory, because a new advanced technology, such as those involving transportation mentioned

[4] This can be by public sale on a stock exchange, private sale, inheritance, or gift to non-relatives.
[5] This does not preclude different goods being produced by different technologies, and an economy consisting of a mixture of types of firms using different technologies.

above, must involve the initial allocation of resources used to create, adopt, and use such a technology and not just the inputs of labor and capital into an established technology which produces output with a lag. We mean by "delay" the time that must elapse between when the initial resources or inputs are allocated to the creation and use of a new technology and when the output results.

In the model economy we specify, it is not obvious false that by selling the rights to the future output produced using the long delay technology that a proprietor can efficiently utilize the same technology using the same optimal intertemporal input and output distribution patterns as a corporation. This is the first result which we rigorously derive (in Theorem 1). The intuition for this important result is clear for the example when individuals desire to consume equally in their youth and old age but are only productive in their youth. The potential deathlessness of a corporation enables a corporation to internally transfer the increase productivity that will occur in the distant future to the income of its current stakeholders (who make the relevant decisions). A corporation can make contracts that achieve both the most productive allocation of inputs to ***only*** the longest delay, most productive technology and the distribution of the resulting output as income/consumption to all of its stakeholders that is optimal for each, e.g. equally in both their youth and old age. We emphasize that the existence of productivity delays is critical for this conclusion.

The requirement that a proprietor allocate and pay factors their marginal produce not only makes incorporation a new source of economic growth, but this also eliminates the well-known "competitive Market Failures" of Samuelson (1957) and Diamond (1965), as well as a new one when new advanced technology with a delay appear. These alleged failures for agents to achieve thru their voluntary choices the most efficient economic outcome, is due to the (implicit) assumption that output is produced by proprietors, not corporations.

We demonstrate that economic growth achieved through the adoption of innovations with long productivity delays is necessarily associated with increased income inequality for both self-employed proprietorships and corporations. However, theoretically the increased inequality between young and old proprietors is permanent, because the different time horizons of young and old proprietors in each generation dictate different labor allocations to technologies with different productivity delays. In contrast, the income inequality between a corporation's young employees and old equity owners is transient. When an advanced technology is adopted by a corporation income inequality is increased precisely because corporations *do* place transferring the value of future output into current equity owner income ahead of employee wages. They must, because equity owners will not agree to the adoption of a new technology unless they benefit. However, the employee is compensated in their old age from the increased productivity, and this income inequality dissipates with economic growth and competition for employees. A corporation is not constrained to pay factors their marginal products and increased income equality can (costlessly) increases the welfare of all of a corporation's stakeholders.

This new reason for firms to incorporate also implies that the benefits to incorporation are independent of the motivation of a firm's stakeholders, i.e. whether they are selfish, altruistic, or a combination of the two. The common view in economics, consistent with much economic modeling, is that agents are strictly selfish and want the goal of a firm to be the maximization of the individual shareowner's wealth and welfare. This is termed the "shareowner's" view of the corporation, Kay (2017), and is exemplified by Magill, Quinzii and Rochet (2015) and Friedman (1970), amongst others. The alternative is that a corporation is a "social organization" whose goal is to increase the "welfare" or "social norms" of a group, Drucker (1962) and Arrow (1969). Such goals are, at least in part, altruistic and social. Our demonstration of the increased efficiency and productivity resulting from incorporation does not depend whether its equity owners are selfish or altruistic. Moreover, we cite many examples of corporations which explicitly state that their goal is not to maximize the wealth of their individual equity owners (some of which do not even have individual shares), but are by any measure very successful, because they (sometimes create), adopt, and use the most advanced technologies.

The model and framework is presented in the next section, followed by the optimal choices for an unincorporated firm, and then for a corporation. In the latter we demonstrate that in a steady state equilibrium a corporation will make the same choices as a benevolent central planner (Theorem 2). Section IV analyzes the incentives for a proprietor to incorporate in this model economy, (Theorem 3). Section V argues that if proprietors choose to incorporate that some of the familiar "Completive Market Failures" vanish. Section VI presents diverse empirical support for our hypothesis, including the recently reported evidence by Comin and Mestieri (2018) that rich countries adopt advanced technologies at the same rate as poor counties, but utilize them more intensely. As well as that of Poschke (2018) that rich countries have larger sized firms than do poor countries. Both of which can be explained by the relative concentration of corporations, and the fact that corporation's are more efficient that unincorporated firms. The next section evaluates the pervasive "shareowner's" view of the corporation vs the alternative. The paper end with our conclusions and what these might imply.

II. Model and Framework

Consider a variant of Samuelson's canonical, competitive, 2-generation, over-lapping generations (OLG) model economy consisting of selfish, rational agents who have productive labor only in their youth. At the beginning of their youth, an individual is born a self-employed proprietor (SEP) and can choose to remain a SEP or form, or join (if it exists), a corporation. We assume that there is no cost for a proprietor to convert to or join a corporation. However, their choice maybe conditioned upon the choices made by the preceding generation(s). Because population and human capital growth are not important to our argument, we assume they equal zero. To demonstrate that our new hypothesis is independent of any theories of the firm based upon contracting, transactions, and/or information costs, we specify a model economy with no uncertainty and complete knowledge by all agents. In addition, to isolate our new hypothesis from the argument that a corporation has an advantage in accumulating productive capital, we assume that there is no physical capital and only labor is used in production.

A. Production Functions with Delayed Output

The production function of output for a perishable consumption good, $Q(t)$, produced in period *t,* using a contemporaneous technology that results in total factor productivity (TFP), $A(t)$, and labor, $L(t)$, is,

$$Q(t) = F\big(A(t), L(t)\big). \tag{1}$$

Consider an alternative in which a sequence of technologies for which the *m*th technology has an output delay of $m = \emptyset, 1, \ldots, M, \ldots x$ ($\emptyset = 0$ distinguishes zero from *O* for old) and the TFP of A^m increases with the length of the delay,

$$A^{\emptyset} < A^1 < A^2 < \ldots < A^x \,, \tag{2}$$

where *x* is the delay associated with the most productive technology. At time *t*, assume only *M* out of the set of possible technologies are available, but new, more advanced technologies can appear exogenously with the passage of time.[6]

The endowment of labor, $L(t)$, of each young agent is supplied inelastically and $L(t) = L$ is a constant, e.g. 20 hr. @ wk. The total market labor supply is $\sum_B L = (1+n)L = BL$, when B is the number of agents in generation, t, and the rate of population growth is assumed to be $n = 0$. Denoting proprietors and corporations with the superscript $j = P$ or C, firm j can partition the labor it has at time t into allocations to the $M \leq x$ technologies available,

$$L = \ell^j(t, \emptyset) + \ell^j(t, 1) + \cdots \ell^j(t, M), \tag{3}$$

where $\ell^j(t, m) \geq 0$, denotes firm j's labor allocated in period t to technology m that results in output in period $t + m$. Term the proportions of each young proprietor's labor, $L = \ell^P(t, \emptyset) + \ell^P(t, 1) + \cdots \ell^P(t, M)$, allocated to $A^{\emptyset}$, A^1, … and A^M as $\delta^P_{\emptyset}$, δ^P_1, …and δ^P_M, such that $\ell^P(t, \emptyset) = \delta^P_{\emptyset} L$, $\ell^P(t, 1) = \delta^P_1 L$, …and $\ell^P(t, M) = \delta^P_M$, where $(1 - \delta^P_{\emptyset} - \delta^P_1 \ldots - \delta^P_{M-1}) = \delta^P_M$. A firm's output in period t associated with labor input $\ell^j(t - m, m)$ in period $t - m$ using technology m is denoted[7]

$$Q^j(t, m, t - m) = A^m f^m(\ell^j(t - m, m)), \tag{4}$$

where $f^m(\ell^j(t - m, m)$ denotes the production function that uses delay technology m and inputs from period $t - m$. Firm j's total output at time t associated with past and present allocations of labor to all technologies is

$$Q^j(t) = \textstyle\sum_M A^m f^m(\ell^j(t - m, m)). \tag{5}$$

For our purpose, it suffices to assume that the production function is the same for all technologies, $f^m = f$, and $f^m(\cdot)$ is homogeneous of degree 1, e.g. Cobb-Douglas. Thus, equations (4) and (5) simplify to,

$$Q^j(t, m, t - m) = A^m f\left(\ell^j(t - m, m)\right) = A^m \ell^j(t - m, m), \tag{6}$$

[6] We abstract from the issues of endogenous technological progress.
[7] Although this notation is slightly redundant, it makes the notation for forward contracts easier later on.

$$Q^j(t) = \sum_M A^m f(\ell^j(t-m,m)) = \sum_M A^m \ell^j(t-m,m). \quad (7)$$

The marginal products of labor (MPL) are $\partial Q^j(t)/\partial \ell^j(t-m,m) = Q^j(t)/\ell^j(t-m,m)$.

B. Income, Consumption, and Lifetime Welfare

The amount of output depends upon the type of firm and the production technology it uses, and these factors also affect how output is allocated to income and income to consumption. Denote the young and old generations by the superscript $i = Y$ and O. The young and old agent i of generation *t*'s consumption in period *t*, whose income comes from firm type j, is $C^{j,i}(t)$. Following Samuelson, current utility of an agent of generation *t* is simply $U^{j,i}(t) = lnC^{j,i}(t)$ and, where $1 \leq \beta < \infty$ is the discount rate between goods of period *t* for goods of period *t* +1,[8] lifetime welfare is

$$U^j(t) = U^{j,Y}(t) + \beta U^{j,O}(t+1) = lnC^{j,Y}(t) + \beta lnC^{j,O}(t+1). \quad (8)$$

$U^j(t)$ is the sum of the present values of the utilities of an individual's consumption over their lifetime or their lifetime welfare. An individual agent's intertemporal budget constraint is

$$W^{j,Y}(t) = I^{j,Y}(t) + \beta I^{j,O}(t+1), \quad (9)$$

where $W^{j,Y}(t)$ is the lifetime wealth of a young individual born in period *t* whose income, $I^{j,Y}(t)$ and $I^{j,O}(t+1)$, comes from firm type j. This implies the optimal allocation of consumption, $C^{j,Y}(t) + \beta C^{j,O}(t+1) \leq W_t^{j,Y}$. Assume $\beta = 1$ as a leading case and, when the only durable asset is fiat money, that there is no change in its purchasing power.

C. Firm Type and Contracting Constraints

As mentioned in the introduction a young agent is born a self-employed proprietor (SEP) and may continue to be a SEP when old. A SEP can only rationally adopt a technology with a delay longer than their lifetime if they make a forward contract for the property rights to the output which results after their demise.

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[8] This is Samuelson's specification of time preference (ibid., P. 474 and 477), not Diamond's, and affects Diamond's counterpart to equation (8), (op. cit., P.1134). Diamond's $U^j(t)$ could be termed an "average" lifetime welfare per period.

Alternatively, a young SEP may form a corporation becoming both its initial employee and equity owner, or join an existing corporation. As a separate legal entity from any individual, a new corporation can make contracts and commitments that are legally separate from those made by its equity owners (or employees) even though they may act as its agents.[9] This new corporation can (and must in order to continue to exist) then hire new young employees in each subsequent period, including in the initial founder's old age, and transfer the equity ownership from one generation to succeeding ones.[10]

Although Acemoglu insightfully observed "how differences in the ability to write contracts between firms and their suppliers (or firms and their workers) may have first order effects upon technological adoption decisions" (2009, p. 631), he did not distinguish between an unincorporated and an incorporated firm's ability to write contracts. In particular, a corporation's ability to make complex contracts or plans of long duration between itself and its own future stakeholders, both employees and equity owners, in order to increase the efficiency with which advanced, delayed technology is used and the resulting output is distributed. This is what our hypothesis adds to his observation.

A corporation can make contracts binding current and all future stakeholders that specifies the allocation of inputs to the technologies with different delays, the wage paid a new employee, how they will become an equity owner, and receive income in their old age in either dividends, increased pension benefits, or pay for unproductive employment in every period. Such a contract is constrained only by the requirements that a corporation's balance sheet (and income statement) balance if all inputs are paid (the present value of) their lifetime marginal product, and that the lifetime welfare of each generation increase, so that each succeeding generation of stakeholders is better off joining the corporation than choosing to be a SEP (until a new steady state is reached). This ensures the potential deathlessness of the corporation. Such a contract enables current input allocations and output distributions for a corporation to be different from those that are possible for a SEP, even when SEPs make (optimal) forward contracts.

Regardless of firm type, there is an opportunity cost for adopting an advanced technology with output delays. In the short-run, output and presumably consumption of some agent must

[9] This is the basis for limited liability.
[10] We use the term "equity owner" as distinct from "shareholder", because every corporation has equity owners, but very few have traded shares, Davis, et.al. (2006).

decrease as inputs are reallocated from a no- or short- delay to a longer delay technology. Sacrificing current consumption is a form of investment and creates intangible capital – the claim to the value of the future increased output.

In what follows, we exposit the choices of each type of firm on the basis of whether the most advanced available technology involves delays shorter or longer than the life span of an individual, i.e. $M <$ or ≥ 2.

II. Optimal Choices for an Unincorporated Firm

A. *When Short Delay Technologies* $A^{\emptyset}$ and A^{1} *are Available to a Proprietor.*

Assume in periods $t \leq 1$ that $A^{\emptyset}$ and A^{1} technologies are available. A young SEP allocates a proportion, $\delta_{\emptyset}^{P}$, of their labor to $A^{\emptyset}$, where $\ell^{P}(t=0,\emptyset) = \delta_{\emptyset}^{P}L$, and the remainder $\delta_{1}^{P} = \left(1-\delta_{\emptyset}^{P}\right)$ to A^{1}, where $\ell^{P}(t=0,1) = \delta_{1}^{P}L$, and $L = (\delta_{\emptyset}^{P} + \delta_{1}^{P})L$. This results in the output $Q^{P}(t,\emptyset,t) = A^{\emptyset}\delta_{\emptyset}^{P}L$ when young, and is equal to the young agent's income and consumption, $I^{P,Y}(t) = C^{P,Y}(t)$. It also results in the output $Q^{P}(t+1,1,t)$ when the agent is old, equal to their income and consumption of $A^{1}\delta_{1}^{P}L = I^{P,O}(t+1) = C^{P,O}(t+1)$. Thus, the existence of delayed production can eliminate the need for both money and saving.

Lifetime welfare of an agent of generation *t* is,

$$U^{P}(t) = ln[A^{\emptyset}\delta_{\emptyset}^{P}L] + \beta ln[A^{1}(1-\ \delta_{\emptyset}^{P})L]. \tag{10}$$

This is maximized by the choice of $\delta_{\emptyset}^{P} = 1/(1+\beta)$ and, as $1 \leq \beta$, $\delta_{\emptyset}^{P} \leq 1/2$.

In order to compare the effects upon lifetime welfare of an agent in this model when they choose to be a SEP to that they would receive if they formed a corporation when different technologies are available, we specify a numerical paradigm and calculate the resulting values of welfare. Assume $L = 20$, $\beta = 1$, and total factor productivities are $A^{\emptyset} = 1$ and $A^{1} = 10$. The optimal allocation of labor is $\delta_{\emptyset}^{P} = 0.5$, and results in outputs, $Q^{P}(t,\emptyset,t) = A^{\emptyset}\delta_{\emptyset}^{P}L = 10$ and $Q^{P}(t+1,1,t) = A^{1}\delta_{1}^{P}L = 100$, and income and consumption when young and old of, respectively, $I^{P,Y}(t) = 10 = C^{P,Y}(t)$ and $I^{P,O}(t+1) = 100 = C^{P,O}(t+1)$. The resulting lifetime welfare of an agent born in period $t = 1$ is $U^{P}(t) = 6.908$.

B. When a Long Delay Technology A^2 becomes Available to a Proprietor.

Assume that, in period $t = 1$, A^1 was the most productive available technology, and a new, much more productive technology, A^2, e.g. $A^2 = 1000$, becomes available in $t = 2$. Each young member of that generation has an incentive to adopt A^2 and reallocate some of their inputs to this new, more productive technology if, when old in $t = 3$, they are able to negotiate a contract to transfer their right to any output produced after their demise to a youth of the next generation. The youth that buys this contract can consume the output produced, $Q^P(t = 4, 2, t = 2)$, in their old age, i.e. $t = 4$. The youth of generation $t = 3$ (and every subsequent generation) must pay for this forward contract out of their income when young. This income, equal to their marginal product of labor multiplied by the amount of labor they allocate to this technology, and thus the output they produce using the no-delay technology, $A^{\emptyset}$, must also fund their consumption when young. Term the amount of income that is exchanged for the right to the output in this forward contact as the price and denote it as $P^{OY}(t = 4, 2, t = 2)$, because it is negotiated between the old (*O*) and the young (*Y*) for delivery in period $t = 4$, using technology A^2 for output created by generation $t = 2$. In addition to production using the technology $A^{\emptyset}$ and A^1, the youth of future generations, i.e. $t > 3$, have a similar incentive to allocate some of their inputs to production using the long delay technology, to sell the resulting output in a forward contract when they are old to the next generation, and to use some of their current income to buy a forward contract for the output that the preceding generation chose to produce using that technology.

This series of forward contracts changes the budget constraints of the young and old agents from what they would be if there were no forward contracts, as well as the production and consumption of output produced by such long delay technology. Consider the optimization problem of an agent of generation t, for any $t \geq 3$. Their consumptions when young and old are,

$$C^{P,Y}(t) = A^{\emptyset}\ell^P(t, \emptyset) - P^{OY}(t + 1, 2, t - 1). \tag{11}$$

$$C^{P,O}(t + 1) = A^1\ell^P(t, 1) + A^2\ell^P(t - 1, 2) + P^{OY}(t + 2, 2, t). \tag{12}$$

From these, they derive lifetime welfare of

$$U^P(t) = \ln\left[A^{\emptyset}\delta^P_{\emptyset}L - P^{OY}(t+1,2,t-1)\right] + \quad \beta\ln[A^1\delta^P_1 L + A^2(1-\delta^P_{\emptyset} -\delta^P_1)L + P^{OY}(t+2,2,t), \tag{13}$$

where the wage income they receive when young is $A^{\emptyset}\delta^P_{\emptyset}L$. They pay $P^{OY}(t+1,2,t-1)$ for the forward contract for the output they will consume in their old age, $A^2\delta^P_2 L$, which was produced by generation $t-1$, and the remainder is consumed in their youth. When old, they also consume the income from the labor they allocated to the delay technology, $A^1\delta^P_1 L$, the output from the forward contract they purchased when young, $A^2\delta^P_2 L$, plus what they receive in payment from the young of the next generation for the output which they chose to be produced after their demise, i.e. $P^{OY}(t+2,2,t)$.

The solution to this dynamic optimization problem is complex because it involves the prices of two forward contracts for each generation. So the optimal choice of any generation is dependent upon those made by the preceding generation as well as every future generation. We have been unable to algebraically derive the terms of the *optimal* sequence of such forward contracts or plans (if they exist) for the period of transition between the two steady state equilibriums. This involves specifying the production choices of the initial and all future SEPs starting at the initial steady state equilibrium of a SEP (that uses the shorter delay, lower productivity technologies $A^{\emptyset}$ and A^1) and converges to a new steady state equilibrium, which uses these plus the longer delay higher productivity technology A^2.

We solve the simpler and more conventional problem of the optimal choice in a steady state equilibrium of the SEP's allocation of its labor between the three available technologies and the price of a forward contracts for the output produced with a long delay. This will allow in a steady state equilibrium the comparison of the welfare of a SEP who cannot make forward contracts and therefore cannot adopt technologies with long delays, to that of a SEP who can do so, as well as to a stakeholder in a corporation that can use the more advanced, delayed technology. This enables the measurement of the long run incentive for a proprietor to create forward contracts as well as to incorporate.

We can also demonstrate the existence of a plan for the transition from the original steady state using $A^{\emptyset}$ and A^1 to the new steady state using these plus A^2 by means of forward contracts for these SEPs. Although we cannot demonstrate that this transition path is optimal, we can demonstrate that it is feasible and that it does involve increasing welfare for the initial and all subsequent generations of SEP until the new steady state equilibrium is attained. Therefore it demonstrates that the initial and all subsequent SEPs have an incentive to adopt and use, with increasing efficiently, a transition path from the initial steady state equilibrium using only $A^{\emptyset}$ and A^1, to the new one that uses these plus A^2, when they can make forward contracts.

We state this as Theorem 1.

Theorem 1. *In a steady state equilibrium, when the choices and welfare of agents in every generation are equal and a more productive technology with a delay longer than the lifetime of an individual proprietor is available, e.g. A^2 in addition to $A^{\emptyset}$* and A^1, *a self-employed proprietor* (*SEP*) *must, A) always be inefficient because of the requirement that it pay factors their current marginal product. This is true even when SEPs can create and sell forward contracts that enable the adoption and use of the more productive technology and, B) such contracts have the optimal prices that maximize a SEP's welfare, C) because it must allocate some labor to the least productive, no-delay technology. D) There exists a plan or contract for the transition period from the initial to the new steady state equilibriums for the sequence of SEPs that increases the lifetime welfare of each generation over that of the preceding one from the initial to the new Steady state equilibrium.*

Proof: A) In a steady state equilibrium in the model presented above, SEPs of generations $t \geq 3$ will optimally allocate their labor and set the price of the forward contracts for the output produced using the different technologies when factors of production are paid their current marginal product. Each young proprietor's labor, $L = \ell^P(t,\emptyset) + \ell^P(t,1) + \ell^P(t,2)$, allocated to $A^{\emptyset}$, A^1, and A^2 is $\ell^P(t,\emptyset) = \delta_{\emptyset}^P L$, $\ell^P(t,1) = \delta_1^P L$, and $\ell^P(t,2) = \delta_2^P L$, where $(1 - \delta_{\emptyset}^P - \delta_1^P) = \delta_2^P$. Thus a young SEP is paid a wage /income equal to $\delta_{\emptyset}^P L$. The allocation of $\delta_2^P L$ to the technology A^2 by a young proprietor in period *t* produces the delayed output $Q^P(t+2,2,t)$, to which they sell the right when they are old, in $t+1$, in a forward contract to a new young SEP of the next generation at the price $P^{OY}(t+2,2,t)$, and they also buy a forward contract from the preceding generation at the price $P^{OY}(t+1,2,t-1)$, in order to consume that delayed output in their old age. In a steady state, these prices must be equal and we term them simply P^{OY}. After making these substitutions into equation (13), the conditions for the optimal choices are;

The F.O.C. with respect to δ_1^P is,

$$dU^P(t)/d\delta_1^P = \beta[A^1L - A^2L]/C^{P,O}(t) < 0. \tag{14}$$

δ_1^P must be non-zero. Thus, because $A^2 > A^1$ its optimal value is equal to the boundary value, $\delta_1^P = 0$.

B) The F.O.C. with respect to P^{OY} is,

$$dU^P(t)/dP^{OY} = -1/C^{P,Y}(t) + \beta/C^{P,O}(t). \tag{15}$$

This is positive if, $A^2 < \delta_\emptyset^P(A^2 + \beta A^\emptyset)$. In the previous numerical paradigm (where $\beta = 1$, $A^\emptyset = 1$, $A^1 = 10$), if we add $A^2 = 1{,}000$, then $\delta_\emptyset^P$ must be < 0.999 for this to result. Thus, $dU^P(t)/dP^{OY}$ is plausibly positive and P^{OY}, which has to be non-negative, is equal to its boundary value of zero.

C) The F.O.C. with respect to $\delta_\emptyset^P$ is,

$$dU^P(t)/d\delta_\emptyset^P = A^\emptyset L/C^{P,Y}(t) - \beta A^2L/C^{P,O}(t) = 0. \tag{16}$$

Assuming $\delta_1^P = 0$ and $P^{OY} = 0$, this solves for $\delta_\emptyset^P = 1/(1+\beta)$. In turn, this implies $\delta_2^P = \beta/(1+\beta)$, because $\delta_2^P = 1 - \delta_\emptyset^P$, when $\delta_1^P = 0 = P^{OY}$.

This is exactly the same optimal steady state division of labor as was found for a SEP when only $A^\emptyset$ and A^1 were available.

This solution generalizes when longer, more productive technologies $A^3, A^4, \dots A^M$ become available; the sequence of future generations of SEPs will each use a similar choice of allocations for the no-delay technology, $A^\emptyset$, and the most delayed and productive technology to produce the output consumed in their old age. This solution implies that all but a negligible part of the output produced using the no-delay technology $A^\emptyset$ is consumed when young, and the consumption when old is entirely from the delay technology A^M purchased by a forward contract when young for a negligible or zero price, i.e. $P^{OY} = \varepsilon \approx 0$.

D) A plan that achieves the favorable outcomes described, for a SEP that adopts the technology A^2 and creates a series of forward contracts to do so, is presented in Table 1. In period $t = 1$, only $A^\emptyset = 1$ and $A^1 = 10$ are available and the optimal steady state values of the variables are in bold. A^2 becomes available in period $t = 2$ and a young SEP reallocates a small amount of labor to the new technology, $\ell_{t=2}^{P,2} = 0.1$, from A^1, and creates the right to the future output after its demise of $Q_{t=4}^{P,2} = 100$. In order to reward the initial generation for choosing to adopt A^2, more labor is allocated to $A^{\emptyset}$, $\ell_{t=2}^{P,\emptyset} = 10.7 = C_{t=2}^{P,Y}$, and the allocation to A^1 is reduced (thus less output will be produced in its old age, $Q_{t=3}^{P,1} = 92$). Despite this reduction in output and consumption when old, these actions will increase generation $t = 2$ welfare to $U^P(t = 2) = 6.924$, because it can sell the right to the future output, $Q_{t=4}^{P,2} = 100$, to a young SEP of generation $t = 3$ for the price of 3 units, resulting in its consumption when old of $C_{t=3}^{P,O} = 92 + 3 = 95$.

The young SEP of generation $t = 3$ allocates its labor to current output,$\ell_{t=3}^{P,\emptyset} = 10.0 = I_{t=3}^{P,Y}$, plus some labor $\ell_{t=3}^{P,1} = 7.0$ for output that will be produced when they are old, in $t = 4$, and the remaining labor $\ell_{t=3}^{P,2} = 3$ to output that will be produced in period $t = 5$ after their death. They will reduces their consumption when young in order to pay 3 units for the forward contract, $I_{t=3}^{P,Y} - C_{t=3}^{P,Y} = 3$ and their income in old age from the 1 period delay technology will be reduced to $Q_{t=4}^{P,1} = 70$. They will increase the production from the 2-period technology that they will sell the rights to in a forward contract, $Q_{t=5}^{P,2} = 3000$, for the price of only 1 unit in their old age to the young of generation $t = 4$. Despite these reductions in its current income and consumption and its production of output when old, it can increase its welfare to $U^P(t = 3) = 7.088 = ln(C_{t=3}^{P,Y}) + ln(C_{t=4}^{P,O})$.

The next generation $t = 4$ achieves the optimal steady state allocation of inputs, but the allocation of income between the young and the old cannot be attained until generation $t = 7$, as portrayed in Table 1. The welfare of each succeeding generation increases over its predecessor until the steady state equilibrium is reached.

Table 1
The Incentive to Adopt Long-Delay Technology and Create Forward Contracts for a Sequence of Proprietors when Technologies $A^{\emptyset} = 1, A^{1} = 10, A^{2} = 1000$ become Available in $t = 2$.

Period	$\ell_t^{P,\emptyset}$	$\ell_t^{P,1}$	$\ell_t^{P,2}$	$Q_t^{P,\emptyset}$	$Q_t^{P,1}$	$Q_t^{P,2}$	$\sum Q_t^{P,m}$	$I_t^{P,Y}$	$C_t^{P,Y}$	P^{OY}	$I_t^{P,O}$	$C_t^{P,O}$	$U^P(t)$
$t = 1$	**10.0**	**10.0**	**0**	**10.0**	**100**	**0**	**110**	**10.0**	**10.0**	**0**	**100**	**100**	**6.908**
$t = 2$	10.7	9.2	0.1	10.7	100	0	110.7	10.7	10.7	0	100	100	6.924
$t = 3$	10.0	7.0	3.0	10.0	92	0	102	10.0	7.0	3	92	95	7.088
$t = 4$	10.0	0.0	10.0	10.0	70	100	180	10.0	9.0	1	170	171	10.204
$t = 5$	10.0	0.0	10.0	10.0	0	3k	3,010	10.0	9.5	0.5	3k	3,000.5	10.258
$t = 6$	10.0	0.0	10.0	10.0	0	10k	10,010	10.0	9.75	0.25	10k	3,000.25	11.488
$t \geq 7$	10.0	0.0	10.0	10.0	0	10k	10,010	10.0	10.0	0	10k	10k	11.513

Note, k denotes thousands. ■

Notice the large inequality in the distribution of income between the old and the young due to the type of firm being a proprietor. This inequality increases dramatically as the SEP adopts more advanced technologies, e.g. from 10 to 1 when $A^{\emptyset}$ and A^{1} are used, to 1000 to 1 when A^{2} is used (and so on for A^{M}, $M > 2$).

In a steady state for the above numerical paradigm a SEP that can make optimal forward contracts that allocate labor to the three production technologies $\delta_{\emptyset}^{P} L(t) = 10$, $\delta_{1}^{P} L(t) = 0$, and $\delta_{2}^{P} L(t) = 10$, produces outputs and consumptions of $A^{\emptyset} \delta_{\emptyset}^{P} L(t) = C^{P,Y}(t \geq 3) = 10$ and $A^{2} \delta_{2}^{P} L(t) = C^{P,O}(t \geq 3) = 10{,}000$, and lifetime welfare of $U^{P}(t \geq 3) = 11.513$ for generations $t \geq 7$.

Note that, although the output associated with a forward contract is available and consumed in old age, a young SEP must produce current output and income equal to the current marginal product of labor.

III. Optimal Choices for a Corporation

Assume, for simplicity, in every period that a corporation consists of two stakeholders - one young employee and one old equity owner. A SEP who decides to incorporate becomes the new corporation's initial employee and then when old its equity owner. To continue to exist a corporation must hire, at least, one new employee each period and transfer ownership from one generation to the next. Every employee is rational and cares about the "employment package" over their lifetime, including potential equity ownership, not just the wage paid when young. The best "employment package" will provide a lifetime pattern of income that corresponds to their optimal consumption pattern, e.g. equal in their youth and old age when $\beta = 1$, independent of the pattern of the marginal product of their labor, e.g. when they are only productive when young. Competition in the labor market will ensure that any firm that fails to offer/pay such an "employment package" will cease to exist.[11]

The relationship between the income and the consumption of a corporation's stakeholders depends upon how the equity ownership in the corporation is transferred. If it is by the sale of stock, the amount that a young employee saves and pays for the purchase of the corporate equity from an old agent must be constant in a steady state. Term this $P^S(t)$. Then, $I^{C,Y}(t) = C^{C,Y}(t) + P^S(t)$ and $I^{C,O}(t) = C^{C,O}(t) - P^S(t)$. We will prove that the optimal value of $P^S(t)$ is zero, similar to the price a SEP would pay in a steady state for a forward contract. Because it makes no sense for a price to be zero, we assume that it is extremely small, $P^S(t) = \varepsilon \approx 0$, (and there is no possibility that the appreciation of the stock price affects the income of any agent). Alternatively, if corporate equity ownership is transferred by inheritance or gift, then the corporation can pay a wage equal to $I^{C,Y}(t) = C^{C,Y}(t)$ and dividends equal to $I^{C,O}(t) = C^{C,O}(t)$. In any event there is no meaningful distinction between the current income and consumption of either the old or the young regardless of how they transfer equity ownership in a steady state.

When the only technology available to a corporation is $A^{\emptyset}$, or $A^{\emptyset}$ and A^1, there is no incentive for a SEP to form a corporation because output cannot be increased and its distribution cannot be improved compared to a SEP. To have such an incentive, a corporation must be able to increase its future output beyond the lifetime of its current stakeholders and make a contract or plan to transfer some of the value of that increased future output into current equity owner's income, e.g. via dividends (otherwise a SEP would have made such a contract).

When technologies A^2 and/or A^M are available, in a steady state equilibrium a corporation will use only the most productive technology, A^M, and it will optimally distribute the resulting

[11] Breach of contract is impossible in a world of certainty and complete knowledge.

output as income (in equal amounts if $\beta = 1$) to its stakeholders. We state and prove this in Theorem 2.

Theorem 2. *In the model specified above, in a steady state a corporation maximizes the lifetime welfare of its stakeholders when technologies $A^{\emptyset}$, A^1, A^2, and A^M are available, by only using the most productive technology, A^M, and distributing its output as income to its stakeholders in a intertemporal pattern that is optimal for each agent, exactly the same as would a benevolent central planner.*

Proof: A corporation will maximize its output in a steady state by allocating all labor to A^M, because $A^M f(L) > MAX\left[A^{M-1}f(L), A^{M-2}f(L), \dots A^{\emptyset}f(L)\right]$.

A corporation can pay income (equal to consumption) to its stakeholders in the pattern that maximizes their lifetime welfare exactly the same as would a benevolent central planner,[12] because it is not constrained to pay input factors their current marginal product. From equation (9) this is $I^{C,O}(t)/\beta I^{C,Y}(t) = 1$, and $C^{C,Y}(t) = A^M f(L)/(1+\beta)$, and $C^{C,O}(t) = \beta A^M f(L)/(1+\beta)$. The lifetime welfare of a stakeholder in a corporation with this pattern of income/consumption is clearly greater than that which a SEP can obtain from the same inputs; $U^C(t) = ln[A^M f(L)/(1+\beta)] + \beta l([\beta A^M f(L)/(1+\beta)] > U^P(t) = ln\left[A^{\emptyset} f\left(\delta^P_{\emptyset} L\right)\right] + \beta ln[A^M f((1- \delta^P_{\emptyset})L)]$. For example, when $f(L) = L$, $A^M = A^2$ and $\beta = 1$, then $U^C(t) = 2ln[A^2 L/2] > U^P(t) = ln\left[A^{\emptyset} L/2\right] + ln[A^1 L/2]$. ■

Using the previous numerical paradigm, when employed by a corporation in a steady state equilibrium, the labor of an individual of generation $t = 2$ will optimally be allocated to only production using $A^2 = 1{,}000$ and will produce $Q^C(t = 4, 2, t = 2) = Q^{C,2}_{t=2} = 20{,}000$.[13] In each period, a corporation will distribute this output as income to the young and old stakeholders that is equal to their consumption, i.e. $I^{C,Y}_t = 10{,}000 = C^{C,Y}_t$ and $I^{C,Y}_t = 10{,}000 = C^{C,O}_t$. This will result in lifetime welfare of $U^C(t = 2) = 18.421$. This is a substantial increase over the welfare of the same individual if they were a SEP when the same set of technologies were available and

[12] See Diamond (op. cit., p.1128)

[13] We abbreviate $Q^C(t = 4, 2, t = 2)$ to $Q^{C,2}_{t=2}$, $I^{C,O}(t)$ to $I^{C,Y}_t$, etc. in order to conserve space in the headings of Table 1 below.

they were able to use the more advanced, delayed technology because of their creation and sale of forward contracts (even though these were optimal for the propritor), i.e. $U^P(t = 2) = 11.513$, as reported in the numerical calculation after Theorem 1.

It is interesting to explicitly consider an even more productive technology with three-period output delay. Assume that the technology $A^3 = 10{,}000$ become available, is adopted, and a firm uses it most efficiently in period $t = 3$. In a steady state the corporation will allocate all its inputs of $L = 20$, to A^3, $\delta_3^P = 1$, which produces $Q^{C,3}_{t\geq 3} = A^3 \delta_3^P L = 200k$, and distribute this equally between the young employee and the old equity owner, $I^{C,Y}_{t\geq 3} = 100k = C^{C,Y}_{t\geq 3}$ and $I^{C,O}_{t\geq 3} = 100k = C^{C,O}_{t\geq 3}$. This will result in the lifetime welfare for a stakeholder in the corporation of generation $t \geq 3$ of $U^C(t \geq 3) = 23.026$. This is much larger than that of a similar individual SEP, even when they could optimally create and sell forward contracts. This is a measure of the potential incentive for a SEP to incorporate.

This increase in lifetime welfare comes from two sources. First, the increase in productivity due to the corporation reallocating inputs to their most efficient use and, second, the increase in welfare due to a more optimal income distribution. Both of these result from the corporation not being constrained to pay factors their current marginal product. (We calculate the relative importance of each of these for our numerical paradigm below.)

IV. Will a Proprietorship Choose to Incorporate?

From Theorems 1 and 2, an agent is clearly better off in a steady state equilibrium being a stakeholder in a corporation than being a SEP, even when the SEP can make optimal forward contracts. However, for any firm to adopt an advanced technology with delayed output, there must be a transition period during which the current output, income, and the consumption of some generation of agents is decreased. This is a similar question as for a SEP. It is not obvious that an individual in the initial generation of SEPs, who possibly could form a new corporation and be the corporation's initial employee and equity owner, has the incentive to do so. This is because a corporation's potential deathlessness requires that all future stakeholders in the new corporation never be worse off than if they choose to either be a SEP or to start their own new corporation. Otherwise the new corporation cannot be established because it cannot hire new employees. This requires the new corporation to make a contract or plan for *its initial and all* *future stakeholders* that never decreases their expected welfare over that which they could receive if they choose to be a SEP that can make forward contracts.

How this is achieved can be very complex and, as noted above, we have been unable to algebraically derive the terms of the *optimal* transition plan or contract (if it exists) for a SEP which can make forward contracts between these steady state equilibriums. We are therefore unable to compare the values for the relevant choice variable, including for lifetime welfare, for the initial SEP who chooses to incorporate to those which they would receive from not incorporating. However, any allocation of inputs and any distribution of the resulting output that a SEP can make are subject to the restriction that inputs and the distribution of income to the owners of such inputs must equal their marginal products. It follows that a corporation formed by a SEP can either make exactly the same choices as the SEP or ones that increase the welfare of the initial SEP who incorporate over what they could realize by remaining a SEP using the same advanced technology.

If we can present an example for this new corporation of at least one such welfare increasing, feasible contract for the period of transition for this new corporation that increases the welfare of the initial and all subsequent generations over that of the preceding ones, including that for a SEP before the advanced technology A^2 became available, then we have established the existence of such a contract. This is stated in Theorem 3, which presents the possible terms of one such contract.

Theorem 3. *When an advanced technology, A^2, becomes available, there exists a feasible contract, plan, or commitment that a young SEP can make as part of establishing a new corporation, perhaps as part of its articles of incorporation, that specifies: A) the allocation of inputs to the alternative available production technologies in the initial and all future periods, B) how the output of the corporation will be distributed as income to the initial and all future stakeholders in the corporation in such a manner that each generation of stakeholder's expected lifetime welfare is increased over that they would have received had they chosen to remain a SEP and not adopted the new technology, and is larger than or equal to the preceding generations lifetime welfare, and C) the initial equity ownership and how equity ownership will be transferred to future generations.*

Proof: Part C) is satisfied if the articles of incorporation state whether the agents of one generation transfer their equity ownership to the next by either gift, or inheritance, or sale. Parts A) and B) are satisfied in Table 2, which presents a feasible transition path from the initial steady state equilibrium of the SEP who chose to incorporate and specifies an efficient use the new advanced technology as well as the optimal distribution of the resulting output as income to the young employees and old equity owners in the steady state for the new corporation. It is constructed using the previous numerical paradigm in Table 1 but starts with the initial generation in period $t = 2$ who can choose to incorporate. The optimal steady state for the SEP in period $t = 1$, when only the no- or short-delay technologies $A^{\emptyset}$ and A^1 are available, is presented in the top row in bold. The long delay technology $A^2 = 1000$ is assumed to become available in period $t = 2$ when a young SEP can form the new corporation and becomes both its initial employee and equity owner. In this period, the corporation can allocate its employee's labor between $\ell_t^{C,\emptyset}$, $\ell_t^{C,1}$, and $\ell_t^{C,2}$, as portrayed in the second row labeled $t = 2$. We assume it does so the same as if it were a SEP which makes forward contracts in the first 4 periods, i. e. the same as in Table 1, in order to demonstrate that incorporation is advantageous to the initial SEP that chooses to incorporate in period $t = 2$, even in this case. The next columns of this row present the resultant outputs, their sum, $\sum Q_t^{C,m}$, the income = consumption of the young, $I_t^{C,Y} = C_t^{C,Y}$, and the old, $I_t^{C,O} = C_t^{C,O}$, and finally the lifetime welfare of each generation. The latter depends upon the consumption of generation t both in period t when young and in $t + 1$ when old exactly the same as in Table 1. Note that lifetime welfare steadily increases for subsequent generations of new employees, and these welfare gains are greater than those for a SEP in Table 1, except for the new corporate employees in periods $t = 3$ and $t = 4$. However, these new corporate employees can chose only to either work for the corporation and obtain welfare of $U^C(t) = 7.079$ and 10.079, respectively, or to be SEPs and obtain lifetime welfare of only $U^P(t) = 6.9023$. In period $t = 5$, and thereafter, the corporation allocates all labor inputs to the most productive technology A^2, and produces more efficiently than a SEP could have done, as reported in Table 1. In Table 2 the corporation converges to the new steady state equilibrium in period $t = 7$, where $U^C(t = 7) = 18.421 = ln(C_{t=7}^{C,Y}) + ln(C_{t=8}^{C,O})$.

Table 2.
Labor Inputs, Outputs, and Individual Outcomes of a Corporation Formed by the SEP portrayed in Table 1, when Technologies $A^{\emptyset} = 1$, $A^1 = 10$, $A^2 = 1{,}000$ are Available.

Period	$\ell_t^{C,\emptyset}$	$\ell_t^{C,1}$	$\ell_t^{C,2}$	$Q_t^{C,\emptyset}$	$Q_t^{C,1}$	$Q_t^{C,2}$	$\sum Q_t^{C,m}$	$I_t^{C,Y} = C_t^{C,Y}$	$I_t^{C,O} = C_t^{C,O}$	$U^C(t)$
$t = 1$	**10.0**	**10.0**	**0**	**10.0**	**10.0**	**0**	**110**	**10.0**	**100**	**6.908**
$t = 2$	10.7	9.2	0.1	10.7	100	0	110.7	10.7	100	6.925
$t = 3$	10.0	7.0	3.0	10.0	92	0	102	6.9	95.1	7.079
$t = 4$	10.0	0.0	10.0	10.0	70	100	180	8	172	10.079
$t = 5$	0.0	0.0	20.0	0.0	0	3000	3000	20	2980	11.513
$t = 6$	0.0	0.0	20.0	0.0	0	10k	10k	5k	5k	17.728
$t \geq 7$	0.0	0.0	20.0	0.0	0	20k	20k	10k	10k	18.421

Notice in period $t = 3$ total output of the corporation decreases from that of period $t = 2$. This is a productivity "slump" associated due to the adoption of the new advanced technology. Also in periods $t = 2, 3,$ and 4 the firm continues to use the least productive technology $A^{\emptyset}$ even tough A^2 is available. This is consistent with the concept of a "lock-in-period" during the transition period from a lower to a higher productivity technology the firm continues to use inefficient technology. This is consistent with the evidence that the adoption of new technologies has been historically associated with "lock-in periods" of less productive technologies, Comin and Hobijn (2010). However, perhaps the most significant advantage of the corporate type of firm is that, although it initially has similar "lock-in-periods" as a SEP, in period $t = 5$ the "lock-in-periods" are eliminated and the corporation only uses the most productive technology. As reference to Table 1 reveals, this is not true for a proprietor.

Although a corporation may pay factor inputs their current marginal product, e.g. in period $t = 2$ in Table 2, $I_{t=2}^{C,Y} = A^2 \ell_{t=2}^{C,\emptyset}$, it is not required to do so. In Table 2 it pays labor less than its current marginal product in the next two periods, but more than their marginal product in all of the subsequent periods, e.g. $I_{t\geq5}^{C,Y} > A^{\emptyset} \ell_{t\geq5}^{C,\emptyset} = 0$.

Because utility and welfare is explicitly assumed to be measurable, one can construct a measure of the importance of the increase in productivity relative to the distribution effect of equalizing the income distribution upon the individual's welfare from a SEP choosing to incorporate. Recall in a steady state equilibrium that when A^2 is available the SEP produces a total of 10,010 and achieves $U^P(t)$ = 11.513. Incorporation increases output to 20,000 and total welfare by 6.908 to 18.421. If the distribution of income remained the same, i.e. $C^{P,Y}(t)/\ C^{P,O}(t)$ = 10/10,000, then the gain in welfare due solely to the more efficient use of technology would be approximately, ln(20) + ln(19,980) – 11.513 = 1.385. Thus, the increase in productivity accounts for about 20%, ((1.385/6.908) x 100) of the total gain in welfare and the balance, 80%, can be ascribed to the change in income distribution.[14]

V. The Role of Firm Type in Completive "Market Failures"

It should be clear at this point that the familiar competitive "Market Failure" of Samuelson (1957), in a model economy without durable capital, and Diamond (1965), in a model economy with durable capital, and perhaps, as a third competitive "Market Failure", the inability of a proprietor to utilize long delay advanced technologies efficiently and to distribute income optimally, occur because factors of production are required to be paid their marginal products. This requirement is correct for proprietors, but not corporations. Paying factors of production their marginal product and not the intertemporal distribution of income desired by each employee and equity owner is sub-optimal and not what either a central planner or a rational corporation would do. We have demonstrated that if proprietors chose to incorporate, then the stakeholders in the corporation could be paid in the intertemporal distribution that was optimal for each individual, and allow inputs to be allocated most efficiently, thereby eliminating these competitive "Market Failures".

It may be objected that the Diamond model involves productive capital and the model analyzed here does not. However, the inefficiency in the Diamond model arises from the (implicit) assumption that firms are proprietors What a proprietor would chose to do is compared to what a central planner would chose in order to maximize the utility of each individual (ibid, p.1128). We have demonstrated that a corporation can, and has an incentive to,

[14] Calculated holding output of the SEP at the level 10,010 and distributing it as income equally to the young and the old, so $C^{P,Y}(t)$ = $C^{P,O}(t)$, producing a gain of 2ln(5,005) - $U^P(t)$ = 17.036 -11.513 = 5.523, or 5.523/6.908 ≈ 80%.

make exactly the same choices as a governmental central planner and, consistent with Arrow's view of the corporation, should be viewed as a mini-"state" (but without coercion). When the model economy has both productive labor and capital, a corporation can continue to act the same as a central planned firm (and economy) would, and hence a proprietor's choice to incorporate presumably will eliminate the same inefficiencies as the central planner would, including those involving capital. We explicitly analyze the role of the type of firm in a model with productive capital in a separate paper (which involves more complex issues).

Although complex, it should not be conceptually difficult for a corporation to achieve the efficient allocation of inputs and the optimal distribution of income when there is both productive labor and capital, even when individuals have differing time preferences, in a model economy with no uncertainty and in which all agents have complete knowledge. Hence, it is not true that these alleged "Market Failure" occur because voluntary, rational, individual choices in a competitive market cannot achieve both an efficient allocation of inputs and an optimal distribution of output: The choice of a proprietor to incorporate or not is voluntary and eliminates all the alleged "Market Failures".

VI. Empirical Support

We present six pieces of empirical evidence supporting the hypothesis put forward in this paper; that because corporations are more efficient than proprietors in the use of advanced technology which involves long delays, they should be considered a cause of economic growth. This evidence supports the new explanation for why corporations have come to dominate production in developed, rich economies.

A. The History of the Corporation and Economic Growth

The history of the creation and emergence of the corporation certainly appears to be associated with the creation and emergence of the advanced, long delay (complex) technology of transportation by sea, and thereafter the corporation appears to be a major cause of economic growth in developed economies and Western Europe.

The first corporation with shareholders with transferable equity ownership was the Societé du Bazacle. Its shares were first publicly traded around 1250 and the company survived until 1946 when it is was nationalized.[15] This corporation's major asset was a perpetual lease from a monastery granting access to the Garonne River which provided the time frame necessary to make an investment in future productivity by replacing floating mills with dams and fixed mills.

The creation of the Societé du Bazacle apparently had little effect upon the formation of subsequent corporations or their adoption and use of advanced technology, as the impetus for modern corporations with transferable equity ownership came with the new navigational technology involving a route around the Cape of Good Hope in the late 16th century. This technology, and the modern corporation, were created by the Dutch (VOC) and English (EIC) East India joint-stock companies, established in 1600 and 1602, respectively. Both firms were previously partnerships and then became corporations, with charters granted by their respective governments and transferable shares and limited liability for shareholders. Limited liability provided an advantage in obtaining capital by reducing the potential contracting, transaction and risk costs of owning corporate equity as compared to investing in an unincorporated firm. However, like a partnership, limited liability *per se* did not provide a basis for making long-term investment in capital and more productive, long delay technology. Transferable "permanent" equity capital was required. The evidence for this is that initially the shares of these corporations involved "circulating" capital, which required repayment of principal by the corporation to the equity owner upon request after a short period, e.g. 4 years. This was very similar to a partnership and limited the length of delay of the advanced technologies that these firms had an incentive to create and invest in. However, exploiting the route around Cape of Good Hope required long term investments in the development of ports, navigation routes, a differentiated fleet of ships and its efficient operation (Parthesius 2010), and the passage of many years to acquire and then liquidate the accumulated products from trading before profit could be fully realized, Gelderblom and Jonker (2004). The consequence was that the nature of a corporation fundamentally changed when "permanent" equity capital was required; the modern corporation was born.

B. The Corporation and Subsequent Industrial Revolutions

[15] See Gimpel (1977), Le Bris, Goetzmann, and Pouget (2015), and Stark (2014)

The eventual rise of corporations as the dominant institutional arrangement of the firm in Western economies came in two waves. Each was associated with the creation of technological innovations and their adoption that involved long delays before increased output was realized, Ark and Smits (2007). The first wave in the U.S. followed technological innovations in steam power (1788), railways (1825) and telegraph (1835). Between 1810 and 1860, the number of U.S. corporations grew from about 1000 to more than 22,000, with transportation corporations representing more than 47% of the increase, Sylla and Wright (2013). Significant increases in productivity did not appear until the 1869-1892 period. The second wave followed inventions in steel production (1860s) and electricity (1882), and by 1910 the number of U.S. corporations exceeded 270,000, Hannah (2015).

Recently, Brynjolfsson and McAfee (2014) have argued that the adoption of digital technology since the 1980s in the U.S. is an example of an advanced, more productive, long delay technology. They present supporting evidence that is consistent with our model.

C. Empirical Anomalies Associated with Technological Advances

Brynjolfsson and McAfee argue that the new “Digital” industrial revolution is similar to earlier revolutions and these have similar anomalies. The adoption of advanced technologies by either unincorporated or incorporated firms must cause productivity “slumps” in which output decreases in the early stages of the switch from an older, less productive technology to a newer one. This will also produce changes in income inequality, first a decrease and then an increase in real wages and income. Such a transition from an old to a new technology with long delays also must involve a “lock-in-period” during which the less productive technology continue to be used, Comin and Hobijn (op. cit.). The facts that the U.S. economy has been operating at only 18% of its digital capacity, Manyika et al. (2015), that U.S. equity owner income exceeded the 100-year average by 1.4% between 1985 and 2014, Dobbs, et al. (2016), falling real wages in the 1980s and early 1990s, and the recent evidence that workers in the most highly digitized U.S. industries have been experiencing extraordinary high wage growth, Manyika et al. (op. cit.), is consistent with the U.S. economy currently being in the middle of a “Digital Revolution”.

These facts are also consistent with our model’s theoretical result of a “slump” and “lock-in-period”, see Tables 1 and 2 periods $t = 3$ and 4, which according to our hypothesis, is permanent for a proprietor[16], but is a short-run, temporary period for a corporation, as reported in Table 2. Several researcher have reported observing evidence that such "lock-in-periods" are consistent with firms being corporations, e.g. Comin and Hobijn (op. cit.), and Manyika et al. (op. cit.).

Our model generates increased income inequality between a young and old proprietor when more advanced technologies are adopted, e.g. from 10 to 1 when $A^{\emptyset}$ and A^{1} are used, to 1000 to 1 when A^{2} is used in the early part of the adoption period, and then a subsequent increase in real wages and income. However, in our theory rising income inequality is a short-run phenomenon for a corporation, which dissipates as increased output is realized, unlike a proprietor as a comparison of Tables 1 and 2 demonstrate. In Table 2 by period $t = 5$ there is no income inequality. The corporation can, because it is deathless, and will, because that maximizes the lifetime welfare of every stakeholder, eliminate any sub-optimal distribution of income between the young and old. A corporation will also eliminate the incentive for any personal saving.

D. Factors Associated with Between Country Differences in Growth

Recently two apparently unrelated empirical conundrums were reported. First, that rich and poor countries adopt more productive technologies at the same rate, but rich countries use them more intensely than poor countries do, Comin and Mestieri (2018). Second, rich countries have larger firms than poor countries, Poschke (2018). Acemoglu (op. cit.) suggested that rich countries have an institutional environment that is more favorable to the establishment and growth of firms than poor countries do. If this is because of the productivity advantage a corporation has in using long delay advanced technology hypothesized here, then higher proportion of production by incorporated firms in a country can explain the first conundrum. If more efficient firms are larger than inefficient ones, then corporations should be larger than proprietorships and our new hypothesis also explains the second conundrum.

E. Firm Type and the Creation of Advanced Production Technology

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[16] Several researchers have reported evidence consistent with this result (but without the theoretical basis presented here). e. g. Comin and Hobijn (2004, 2010) and Bergoeing, Loayzan, and Piguillem (2015), Jerzmanowski (2007), Gollin (2008), Taymaz (2009), Baldwin, Leung and Rispoli (2011) and Fritsch and Noseleit (2013).

Presumable a corporation has a greater incentive to create advanced technologies that it can profitably use, than an unincorporated firm has to create technologies which it cannot use, at least efficiently. One measure of the creation of advanced production technology is the granting of utility patents, which are patents involving production. Consistent with our hypothesis that corporations have an advantage in the efficient use of advanced technologies over unincorporated firms when technology involves long delays and that this advantage has increased over time, is the fact that the percent of utility patents granted in the U.S. to corporations relative to all utility patent holders has increased from only 4% in 1880 to 92% in 2014.[17]

F. Some Econometric Evidence of the Effect of Firm Type on Economic Growth

The ideal measure for the distribution of firm ownership would be the contributions of incorporated versus unincorporated firms to GDP. This is unavailable for most countries.

We attempted to estimate the relationship between firm type and total factor productivity (TFP). There appears to be no very reliable measure of these variables internationally. Although the World Bank's Enterprise Survey reports a distribution of firm ownership structure, it is not very accurate because it surveys only registered firms with 5 or more employees. By definition, this excludes smaller and unregistered firms which are likely to be unincorporated proprietorships. Take Armenia as an example of how non-representative the Enterprise Survey percent of sole proprietors can be for an entire economy. Only 0.7% of Armenian firms in the 2013 Enterprise Survey are sole proprietors, yet the informal economy, which includes non-registered firms and self-employed workers, accounted for at least 35% of 2010 GDP according to OECD (2011). The World Bank's percentage of total employment that is self-employed appears to better align with GDP – the value for Armenia was 28% in 2010. TFP at current purchasing power parity (USA=1) is obtained from Penn World, Table 9. Data on both variables were obtained for 102 countries. 1990 is the first year for which TFP is measured for many low-income countries and 2014 is the most recent year for all reported countries. The years for which the percentage self-employment is available varies by country. We measure percentage self-employed by the year closest to 1990 and by the year closest to 2014 for which percentage self-

[17] Nickolas, T. (2011), U.S. PATENT AND TRADEMARK OFFICE, Patent Technology Monitoring Team, (2014, and other years).

employed is reported. Corresponding to our theoretical analysis, the relationship is negative at both points in time and stronger in 2014 - the Pearson and rank correlations are, respectively, -0.51 and -0.55 in 1990 and -0.72 and -0.74, in 2014.[18]

Given the economic incentive to form a corporation, why is the percentage of unincorporated firms so high in many countries? Institutionalists argue that the answer is that between countries differences in "the rules of the game … (that) structure incentives" are the fundamental cause, North (1991).[19] One measure of the rules of the game that can influence firm ownership structure presumably is the World Bank's "distance to frontier" (DTF) of an economy. DTF is an estimate of the best possible regulatory environment for the start-up of a limited liability company (LLC). Unfortunately for our purposes, this is not the same as the U.S. definition of a corporation.[20] DTF is measured on a scale from 0 to 100, with a higher score representing closer to the best possible regulatory environment. We correlated the percentage self-employment and DTF measured in 2014, and found the Pearson and rank correlation coefficients for percentage self-employment and DTF of -0.51 and -0.44, respectively. This supports the hypothesis that the creation of corporations is hindered by adverse regulation. We also estimated the correlation between TFP and DFT for 2014 for the 113 countries for which both measures are available, and found the Pearson and rank correlation coefficients to be +0.47 and +0.63, respectively. This (imperfect) evidence supports the hypothesis that the more adverse the regulatory environment, the lower is economic growth. Taken together this evidence supports our hypothesis that corporations are a key institutional cause of higher growth.

VII. What Is (or Should Be) the Goal of a Corporation?

The result that a corporation in our model can optimally distribute its output as income to both its employees and equity owners supports the view of the corporation as a "social organization". It provides rigorous support for Kenneth Arrow's the view that, "It is a mistake to

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[18] Because it measures a relationship independent of functional form, a rank correlation is more powerful than the Pearson correlation, which assumes linearity.

[19] More recently, Acemoglu, Johnson, and Robinson (2004), Acemoglu and Robinson (2015), and Glaeser, et al. (2004).

[20] According to World Bank Doing Business, internationally a LLC has separate entity status, but in some countries does not have transferable ownership, e. g. in Afghanistan, LLC ownership interests are not divided into shares and ownership interest cannot be transferred. http://www.doingbusiness.org/data/exploretopics/starting-a-business.

limit collective actions to State actions…Indeed, firms of any complexity are illustrations of collective actions" with "social norms" (1969, p. 14).[21]

This is not the pervasive view of the corporation in economics. Rather, presumably based upon the standard assumption in economic theory that individuals are strictly selfish, what is termed the "shareowners" view is. This was recently exemplified by the statement that "the quest for profit … (is) the sole objective of a corporation", Magill, Quinzii and Rochet (2015, p. 1685), and echoes Milton Friedman's (1970) statement, "There is one and only one … responsibility of business …to increase its profits". Simply put, this view assumes the motivation of the equity owners of a corporation is solely to maximize their personal, selfish, welfare and wealth.

We believe that Peter Drucker (1962) was the first to term the corporation as a "cooperative venture" and a "social organization", that has a "corporate personality …and… culture…central to its business performance" (Kay (2017, 10/14 -15).[22] It would appear obvious that most individuals are not strictly selfish, but have some degree of altruism and concern for the welfare of others, including their descendants and future generations.

This is reflected by the facts. Very few corporations have publicly traded shares (most have not even issued shares). In 2000 there were almost 5 million US corporations, but less than 0.2% had publicly traded shares, Davis, et.al. (2006). The majority's equity ownership, 99.8+%, was "closely held" and owned by a social organization such as a church, a small private group, or an individual, who by not having marketable shares were not maximizing their individual's wealth. Even some publicly traded corporations explicitly state that their corporate goals are altruistic. Lincoln Electric Company is a leading example. It is both a listed corporation and is very successful as reflected by the fact that it is the most frequently studied firm by the Harvard Business School. It is famous for explicitly guaranteeing lifetime employment as well as profit

[21] Presumably, by "firms of any complexity" he is referring to corporations.
[22] Also Blair (2013).

sharing for its employees.[23] As stated above, many corporations are not even owned by individual stockowners, but by a social group, and the corporate goal is explicitly stated to not be the maximization of the selfish consumption or the wealth of the individual stakeholders.[24] Perhaps the most extreme example is the many successful, religiously centered, closely held, corporations such as the Hutterite farm corporations. They are famous for using the most modern available advanced technology, yet are as close to pure communism as one can imagine. In addition, not only do they explicitly not pay their employees their marginal product, but they do not even pay them a wage.[25] Yet the success of these corporations is indisputable, e.g. they produce over 60% of the pork marketed in N. Dakota.

Our analysis of why firms incorporate is independent of the motivation of a corporation's equity owners and/or stakeholders. Whether the stakeholders in a corporation are strictly selfish, or strictly altruistic, or a combination, does not affect a corporation's ability, when a new advanced, delay technology becomes available, to allocate its inputs most efficiently and to distribute the resulting output optimally according to whatever its "social norms" happen to be, and superior to what an unincorporated firm could do.

VIII. Conclusions and Implications

The answer to the question posed in the title is: in order to avoid the restriction of allocating and paying factors of production on the basis of their marginal product. When an advanced technology with long delays is available unincorporated firms will produce inefficiently and distribute the resulting output as income suboptimally because of this restriction, even when they can use such a technology by making optimally priced forward contracts for the output produced after the demise of the proprietor.

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[23] https://en.wikipedia.org/wiki/Lincoln.

[24] These facts suggest that the concern of Magill, Quinzii and Rochet (op. cit., p. 1685) is misplaced; a corporation, as a type of firm, in fact encompasses stakeholders whose motivations are both selfish and altruistic.

[25] www.hutterites.org/day-to-day/structure/. Upon the liquidation of one such corporation, a court in South Dakota ruled that its equity was owned equally by all members of the Hutterite colony, even though shares had not been issued to the individuals, only the colony/church, www.casemine.com/judgement/us/5914e33aadd7b049348f898f.

Corporations with transferable equity ownership are potentially deathless, unlike a proprietor. We demonstrated that because of this a corporation can internally make contracts that allocate inputs and distribute the resulting output as income to its employees and equity owners in an intertemporal pattern that is both most efficient and optimal. We demonstrated that such a contract is impossible for a proprietor. The type of firm that produces output in an economy matters greatly.

One must conclude that corporations can, 1) cause economic growth, 2) eliminate alleged "Competitive Market Failures", 3) mitigate or eliminate income inequality between the young and the old, and should be viewed as a "Social Organization" designed to mimic some of the actions that a governmental central planner would take to increase the welfare of the corporation's stakeholders.

This suggests that public policy towards corporations should be radically changed. Particularly, if a government wants more economic growth, the legal environment should be changed to promote the establishment and growth of corporations, not the reverse (as appears prevalent today). Tax policy should have the same objective: taxes on corporations should be reduced or eliminated.

This analysis and these conclusions have a broader implication. If output in an economy is produced by corporations, then Milton Friedman's (1962) argument, slightly modified, is strengthened: the best economic system is competitive, free market, ***corporate*** capitalism. Arguably, Adam Smith's "Invisible Hand" works quite well when output is produced by corporations.

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